REMARKS

The Office Action mailed March 2, 2011, has been received and its contents carefully noted. Claims 1-8, 11-16 and 18-24 were pending. Claims 15, 16 and 18 were withdrawn from consideration as a nonelected invention. Claims 1-8, 11-14 and 19-24 were rejected.

By this Response, Claims 1, 3, 5, 6 and 11 are amended and claims 2, 4, 13, 14 and 19-24 are cancelled. Claim 1, as amended, incorporates the Examiner's suggestion and the subject matters of claims 2, 4, 13 and 14. Claim 6, as amended, includes the subject mater of claims 13 and 14. Claims 3, 5 and 11, as amended, are consistent with the changes made in claims 1 and 6. Support may be found in the specification and the claims as originally filed. No statutory new matter has been added. Therefore, reconsideration and entry of the claims, as amended, are respectfully requested.

The inventions of amended claims 1 and 6 are characterized by combinations of the following features (A), (B) and (C):

(A) The temperature of the substrate in the first step (for forming the first titanium nitride layer) is lower than that in the third step (for forming the second titanium nitride layer).

(B) One of (b1) and (b2):

(b1) The partial pressure ratio of the titanium tetrachloride to ammonia in the first step is lower than that in the third step.

(b2) The second flow rate ratio of ammonia to titanium tetrachloride ($NH_3/TICl_4$ flow rate ratio) in the third step is smaller than the first flow rate ratio in the first step.

(C) Annealing (i.e., second and fourth steps) is performed using N_2 gas or H_2 gas, after both the first and second (for forming the first titanium nitride layer) and the third step (for forming the second titanium nitride layer).

According to the present invention, the first step is performed under a lower temperature and a lower-level presence of $TiCl_4$ (this is apparent from (b1) and (b2)), etching (damage) of the underlying base layer is suppressed. The lower deposition temperature in the first step results in increasing chlorine concentration in the first titanium layer. The annealing steps (second and fourth steps) using N_2 gas or H_2 gas reduce the chloride concentration in the first titanium layer, without using plasma.

Claim Objections

The objections to claims 1 and 19 are noted. Claim 19 has been cancelled rendering its objection moot. Claim 1 has been amended in the manner suggested by the Examiner.

Reconsideration is respectfully requested.

Specification

The specification has been amended to address the point raised by the Examiner in the manner suggested.

Claim Rejection under 35 U.S.C. § 112, second paragraph

Claim 20 is rejected under 35 U.S.C. 112, second paragraph, as failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Applicants respectfully traverse.

Claim 20 has been cancelled rendering its rejection moot. Reconsideration is respectfully requested.

Claim Rejections under 35 U.S.C. § 102

Claims 1-2 are rejected under 35 U.S.C. 102(b) as being anticipated by Fiordalice (US 5420072). Applicants respectfully traverse.

Claim 1 has been amended to include the subject matter of claims 4, 13 and 14, which the Examiner has deemed to be free of this anticipation rejection.[1]

Reconsideration and withdrawal of the rejection is respectfully requested.

Claim Rejections under 35 U.S.C. § 103

Claim 3 is rejected under 35 U.S.C. 103(a) as being unpatentable over Fiordalice. Applicants respectfully traverse.

The deficiencies of Fiordalice relative to claim 1, as amended are noted above.

Reconsideration is respectfully requested. It is not seen how the reliance on Section 103 compensates for the missing teachings. Withdrawal of the rejection is respectfully requested.

Claims 6-7, 19-20, and 23-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wang (US 20020064598). Applicants respectfully traverse.

Wang ('598) recites that, "In a second embodiment, a "composite" TiN layer is formed by alternating process steps (a) and (b) having different NH3:TiCl4 ratios ([0031])."

Table 1 of Wang ('598) shows the process conditions in which the pedestal temperature in process steps (a) and (b) are the same. His is different from the present invention. Wang fails

[1] Fiordalice ('072) teaches a first layer (22) of titanium nitride and a second layer (24) of titanium nitride and deposition conditions. Fiordalice fails to teach or suggest annealing of the substrate after deposition of the first and second of titanium nitride. In addition, the deposition temperatures for the first and second layers of titanium nitride are the same (300 to 800 degrees Celsius).

to teach or suggest annealing of the substrate after each deposition of the first and second layers of titanium nitride. Further, there is no teaching to employ different temperatures in the alternating steps process steps (a) and (b).

It is not seen how the four step process with the prescribed conditions would have been rendered obvious based on the teachings of Wang alone. A proper prima facie case of obviousness has not been established. Withdrawal of the rejection is respectfully requested.

Claims 11-12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wang in view of Yamamoto (US 20020006739). Applicants respectfully traverse.

Wang and its deficiencies are discussed above relative to claim 6, upon which the rejected claims depend.

Yamamoto ('739) teaches a single TiN deposition process and a subsequent annealing. Annealing with ammonia is taught. The problem solved by the instant invention is not taught or suggested. Chlorine concentrations are not mentioned nor are control of these concentrations.

It is not seen how the deficiencies of Wang are addressed by Yamamoto. Withdrawal of the rejection is respectfully requested.

Claims 8, 13-14 and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wang in view of Lee (US 20010002334). Applicants respectfully traverse.

Claims 13-14 and 21 are cancelled rendering their rejection moot.

Claim 8 depends on claim 7 which depends on claim 6.

Wang and its deficiencies are discussed above relative to claim 6, upon which the rejected claims depend.

In Lee ('334), unlike the present invention, the deposition temperatures for the first and second TiN deposition processes are the same. In addition, also unlike the present invention, Lee employs NH_3 gas in the annealing step.

Without guidance, it is not seen how one of ordinary skill would have been lead to select H_2 or N_2 in the annealing process or employ different deposition temperatures in the first and third steps. A solution to a real problem was achieved by the disclosed invention.

It is submitted that a proper prima facie case has not been established withdrawal of the rejection is respectfully requested.

Claim 22 is rejected under 35 U.S.C. 103(a) as being unpatentable over Wang in view of Chen (US 20040198045). Applicants respectfully traverse.

Claim 22 has been cancelled which moots the rejection.

Further it is submitted that Chen ('045) is not a proper reference in light of the priority claim based on Japan 2003-434860. See declaration. Pair indicates receipt of the certified copy of the priority document.

Reconsideration is respectfully requested.

CONCLUSION

All of the stated grounds of rejection have been properly traversed, accommodated, or rendered moot. Therefore, it is respectfully requested that the Examiner reconsider all presently outstanding rejections and that they be withdrawn. It is believed that a full and complete response has been made to the outstanding Office Action and, as such, the present application is in condition for allowance. If the Examiner believes, for any reason, that personal communication will expedite prosecution of this application, the Examiner is invited to telephone the undersigned at the number provided.

It is not believed that extensions of time are required, beyond those that may otherwise be provided for in accompanying documents. However, in the event that additional extensions of time are necessary to prevent abandonment of this application, then such extensions of time are hereby petitioned under 37 C.F.R. 1.136(a), and any fees required therefor are hereby authorized to be charged to Deposit Account No. 02-4300, Attorney Docket No. **033082 M 332.**

Respectfully submitted,
SMITH, GAMBRELL & RUSSELL, LLP

By: /Thomas G. Wiseman/

Thomas G. Wiseman, Reg. No. 35,046
1130 Connecticut Ave., N.W., Suite 1130
Washington, D.C. 20036
Telephone: (202) 263-4300
Facsimile: (202) 263-4329

Dated: June 1, 2011

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